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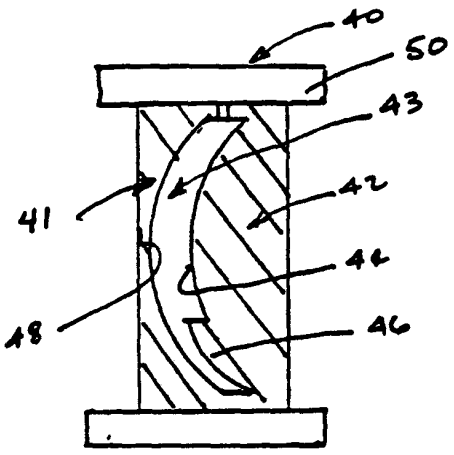
(54) Title: METHOD AND APPARATUS FOR MANUFACTURING DISPOSABLE OPTICAL MOLDS



(57) Abstract

A molding process for manufacturing disposable optical molds which eliminates the need for surfacing and requires only finishing to conform the molded lens to the eyeglass frames. Submaster molds (41) and (42) for forming blanks, are produced to have a form corresponding to the surface of the lens ultimately being formed. Once the desired lens surface configuration is prescribed, the molds are selected, then the lenses are formed by casting.

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METHOD AND APPARATUS FOR MANUFACTURING DISPOSABLE OPTICAL MOLDS

Background and Discussion of Invention

In manufacturing lenses, and particularly lenses for use with eye glasses, the use of plastic is often desirable due to its weight and durability. Normally in manufacturing plastic lenses, two molds in conjunction with the gasket are sealed in a spaced relationship to provide a mold cavity there between. This mold cavity ultimately forms the shape, curvature, thickness and configuration of the product lens. Plastic material is dispensed into the mold cavity and cured to harden the lens with the exterior surfaces being configured to a particular patient's prescription.

In the past, to achieve the final desired surface configuration and optical quality additional surface grinding and polishing of each lens may have been required. In large ophthalmic facilities, it has been economically feasible to employ lens surfacing equipment and technicians to surface and finish the lenses site for each patient. For smaller offices, the capital cost for this approach is typically prohibited.

The mold forms which actually constitute the mold have been in the past made of metal or glass which are ground or formed to the desired shape to create the prescription made by the optometrist, ophthalmologist or other person authorized to do so. Utilizing molds made of metal or glass for this purpose itself is an expensive proposition for both the manufacturer and the user. Whether glass or metal is used it is initially cast and then ground to the desired configuration. A number of different configurations are required to ensure that the desired prescription can be made from these expensive mold

forms. These types of mold forms have produced economic and manufacturing impediments to using certain casting processes at particular facilities.

In the invention described herein a much more economical system has been provided to produce disposable molds of a plastic material with the desired surface configuration and quality that ensures that the lens ultimately formed by the molds has the optical qualities acceptable to the profession. The plastic lens formed can either be a semi-finished blank needing further surfacing or a lens requiring no surfacing and only finishing to conform the molded item to eyeglass frames or other support structure.

The invention described herein overcomes many of the problems discussed above. In one approach an injection molding process is used whereby a liquid monomer material is injected into a submaster cavity which will ultimately form the newly fabricated mold. The plastic, or other material used in forming the mold, utilized in producing a mold form must provide for the transfer of the optical quality from this mold surface to the material ultimately being molded to form the lens. The surface of the mold so formed is optically smooth, without eccentricities. Furthermore, the mold plastic must have an affinity to the type of monomer or polymer which is utilized in forming the lens but also release from the polymer following curing.

In injection molding techniques a submaster which possesses compensating optical surface and curvature qualities is fixed to the parts of the injection molding apparatus to form the mold into the desired configuration. One approach which has proved successful is using electro-formed nickel on a glass substrate to form this optical quality transferring submaster used on the injection molding elements.

Another embodiment discussed herein is the casting of the material using typical molding techniques. Here again the portions of the submaster can be made of metal or glass which have been ground to the necessary surface quality. The submasters are placed in opposed relationship to form a cavity there between and sealed with respect to one another so that the molding material can be received in a sealed relationship. With this approach no pressure is required to dispense the molding material into the cavity making the system relatively easy to use and more economical from an initial investment. In addition, if any further curing is required, any type of curing process can be employed in the casting technique such as ultra violet or thermal curing.

In another embodiment compression molding is used to form the molds. In compression molding a malleable material which will be used in manufacturing the mold form is partially formed into a configuration similar to the form it will have when subsequently molded. The malleable material can be made using one of the other processes discussed above or any other process which will produce a form of optical quality. It is then placed into a submaster which is held in place by a support member. A compression member is then actuated to press the malleable material against the submaster to obtain the desired configuration.

The above has been a discussion of certain deficiencies in the prior art and advantages of the invention. Other advantages will be appreciated from the detailed discussion of the preferred embodiment which follows.

Brief Description of the Drawings

Figure 1 is a side view of an injection molding apparatus.

Figure 2 is a section of the molding apparatus sh wn in Figure 1 taken along lines 2-2.

Figure 3 is an enlarged section of figure 2 taken along lines 3-3.

Figure 4 is a cross section of the mold formed by the processes of invention.

Figure 5 is a cross section of the casting apparatus.

Figure 6 is a schematic of the compression apparatus in a open position.

Figure 7 is a schematic of the compression apparatus in a closed position.

Detailed Discussion of the Preferred Embodiment

As can be seen in Figure 1 the injection molding elements 12 and 14 are arranged in an opposed relationship. Element 14 carries submaster molds 16 and element 12 carries a complementary submaster molds of 18. During the molding operation the elements 12 and 14 will be pressed together in sealing relationship and liquid monomer will be forced into the cavities formed between the submaster molds as can be seen better in Figure 3. In Figure 2, there is shown central opening 30 in fluid connection with channels 32 which are in turn connected to cavities formed by submaster mold elements 16 and 18. The fluid monomer will enter through central opening 30 and pass outwardly through channel 32 to the respective cavities as shown. Once the monomer is cured, injection molding elements 12 and 14 will be displaced or opened to permit the molded forms to fall away and be collected for subsequent use.

The submaster molds 16 and 18 used in this particular embodiment are el ctro formed nickel on a glass substrate. Mold form 18 includes a convex molding surface 24 which includes a bifocal element 28. The rear surface 26 as shown is generally concave, but does not have to be of any particular surface characteristic since it is not interface with the material being molded.

The complementary submaster 16 includes a concave surface 20 which is complementary to convex surface 24 of the mold member submaster 18. The molds are configured and cooperate with elements 12 and 14 to define between surfaces 20 and 24, as shown in Figure 3, a cavity therebetween corresponding to a lens of a selected prescription. During the molding process the liquid monomer will be injected into the cavity between the mold surfaces 24 and 20. Once cured, the injection molding elements are opened, and the mold form 34, as shown in Figure 4, is removed. In this particular embodiment there is also formed a recess 36 corresponding to the bifocal lens element which will appear in the lens ultimately formed. Complementary form can be molded in a similar manner to achieve another interior surface with which the form 34 would ultimately be used.

The plastic mold forms formed by the injecting molding process discussed above will come in many different configurations so that the optometrist or other user making a prescription and ultimately casting the lens will have a sufficient number of forms to choose from in obtaining the desired prescription for the patient.

In another embodiment, rather than using injection molding, the monomer or polymer is simply cast into a casting or mold 40 formed from glass or metal. As can be seen more clearly from Figure 5, in casting the mold, two submaster mold elements 42 and 41 are shown in opposed relationship to form cavity 43 therebetween by the surfaces 44 and 48 respectively. As with the mold forms

discussed above in the injection molding process, one of the submaster mold forms 42 includes a portion 46 which corresponds to the bifocal element on a bifocal lens.

In this particular embodiment the submaster mold forms 41 and 42 are made of glass although they could be made of metal. The interior opposed surfaces forming cavity 43 in mold 40 are either ground or polished to insure that they impart optical quality surfaces to the plastic which is dispensed into the cavity. Once the molds are placed in gasket 50, the material to be molded such as plastic monomer is injected into cavity 43. Once the cavity is filled, the mold can be cured by ultra violet light or thermal or both assuming the necessary initiators are utilized in the composition of the molding material. Although monomers and polymers are utilized as discussed above molten glass or other material which can achieve the desired optical qualities can be employed.

Another form of casting is to use a layering process where a submaster has a layer of liquid monomer placed on the mold surface. This layer is then subjected to an ultraviolet or thermal curing process to harden the layer. The process is then repeated until a sufficient thickness has been accumulated to permit the layered form to be used as a mold. Once the desired thickness is obtained, the mold form is simply peeled away from the submaster.

As with the embodiment discussed above other forms can be made by this process with or without the bifocal portion for use in manufacturing mold forms. The various plastic mold forms would then be shipped to the user where he would select the desired mold forms in preparation of the plastic lens to which he is a desired prescription.

Another embodiment is one of compression molding. The advantage of use of compression molding is that the step of actually forming is a relatively simple one and avoids the need for accurate curing to change the polymer and cure it to a hardened form within and achieve the desired surface quality.

As can be seen more clearly in Figure 6 the support member 52 has a submaster mold surface 54 which will ultimately form one surface of the m ld form. This particular submaster 54 includes an extended portion of 56 which corresponds to a bifocal element on the lens ultimately formed. Complementary press 58 is arranged above the support member 52 with the mold 60 material thereon. The mold material 60 in this instance is malleable and, will have the same characteristics as the mold material discussed above insofar as optical qualities are concerned. Once the mold material 60 is in place, the press 58 is simply forced against the mold material as can be seen in Figure 7 to press it into the desired configuration. Since the submaster mold surface of 54 is in the desired configuration it will cause the material being molded to achieve substantially the same configuration for use as a disposable mold form 62.

Regardless of the method or apparatus that is used in manufacturing the various mold forms they will all be shipped in containers to the user's location. After having made the prescription, the user will select the desired mold forms for each surface of the lens front surface and rear surface. These mold forms are then arranged in a gasket and utilized in a typical casting process to cast the lens form that is desired. The monomer is then dispensed into the cavity formed by the mold forms arranged in the gasket. After curing the casted lens can simply be removed, the edges ground and placed in the glass frames for use by the patient.

The above has been a description of the preferred embodiment of applicants invention. The scope of invention to which applicant is fully entitled is to find in the claims hereafter and any equivalent. In determining the equivalent the detailed discussion of the preferred embodiment should not be interpreted to unduly narrow the scope of the claims.

In the claims:

Claim 1. A method for forming molds for molding lenses comprising:

(a) forming a first submaster: mold having a surface corresponding to front surface of lens to be formed;

(b) forming a second submaster mold having a surface corresponding to rear surface of a lens to be molded;

(c) forming a first cavity with one surface being comprised of said first submaster mold;

(d) molding a first mold form by injection molding of the molding material into said first cavity with one surface of said cavity being said first submaster mold;

(e) forming a second cavity with one surface being comprised of said second submaster mold; and

(f) molding a second mold form by injection molding of the molding material into said second cavity with one surface of said second cavity being said second submaster mold.

Claim 2. The method for forming molds according to Claim 1 wherein said first submaster mold is made of metal.

Claim 3. The method for forming molds according to Claim 1 wherein said first submaster mold is made of glass.

Claim 4. The method for forming molds according to Claim 1 wherein said first and second submaster molds are formed by electro-formed nickel.

Claim 5. The method for forming molds according to Claim 1 wherein said molding material is a plastic monomer material with initiator for polymerization sufficient to impart optical quality to the lenses ultimately formed.

Claim 6. The method for forming molds according to Claim 5 wherein the molding material has affinity to lens material and releases from the lens material following curing of the lens.

Claim 7. The method according to Claim 4 wherein the step of forming said first submaster includes forming a surface configuration different from that of the lens ultimately to be formed to accommodate shrinkage so that as the lens material shrinks it will have a configuration slightly different from that of the mold while achieving a desired prescription.

Claim 8. A method for forming molds for molding lenses comprising;

(a) forming a first submaster mold having a surface corresponding to the front surface of a lens to be formed;

(b) forming a second submaster mold having a surface corresponding to a rear surface of a lens to be formed;

(c) forming a first cavity with one surface being comprised of said first submaster mold;

(d) forming a first mold form by dispensing moldable material into said first cavity;

(e) forming a second cavity with one surfac being comprised of said second submaster mold; and

(f) forming a second mold form by dispensing moldable material into said second cavity.

Claim 9. The method for forming molds according to Claim 8 wherein said step of forming said first cavity is accomplished by arranging said first submaster in an opposed relationship to a front complementary submaster in sealing relationship therewith to form a mold cavity for molding a front surface mold and said step of forming said second cavity is accomplished by arranging said second submaster in opposed relationship to a rear complementary submaster in sealing relationship therewith to form a mold cavity for molding a rear surface mold.

Claim 10. The method according to Claim 9 further comprising curing the lens material in said cavities until sufficiently hardened for use as a lens, and breaking the mold sealed relation to remove the mold forms from said cavities.

Claim 11. The method for forming molds according to Claim 10 wherein said first and second submaster molds and said complementary submaster molds are made of glass.

Claim 12. The method for forming molds according to Claim 11 wherein said first and second submaster molds and said complementary submaster molds are made of metal.

Claim 13. The method for forming molds according to Claim 11 or 12 wherein the step of curing the lens formed in said cavity includes curing by ultraviolet and thermal curing steps.

Claim 14. A method for molds for molding lenses comprising;

(a) forming a first submaster having a surface corresponding to the front surface of a lens to be formed;

(b) forming a second submaster mold having a surface corresponding to a rear surface of a lens to be molded;

(c) arranging said first submaster of mold on a support member;

(d) providing lens molding material in malleable form on said first submaster when on said support member; and

(e) arranging a press above said support member and forming said press against said lens molding material member into the molding material to deform the molding material to have a surface substantially identical to that of the first submaster mold.

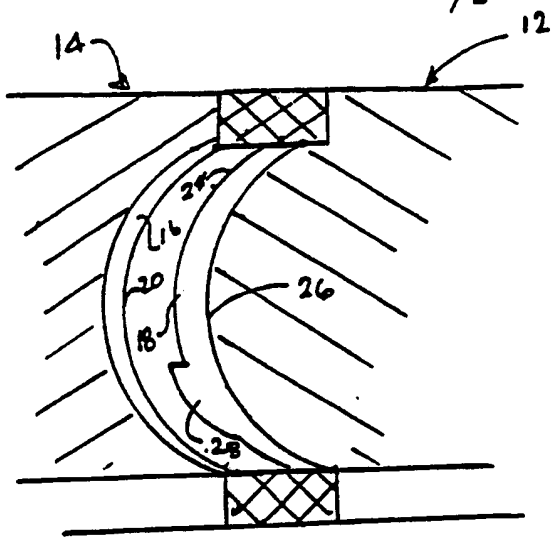

FIG.3

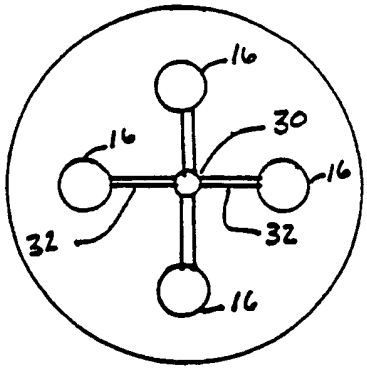

FIG.2

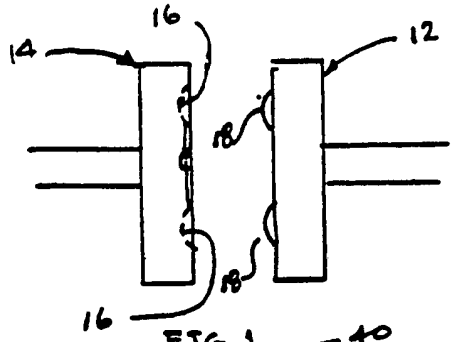

FIG.1

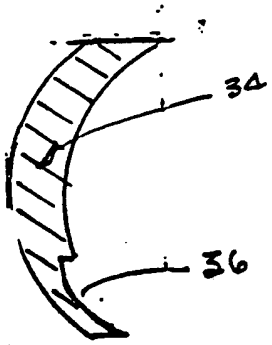

FIG.4

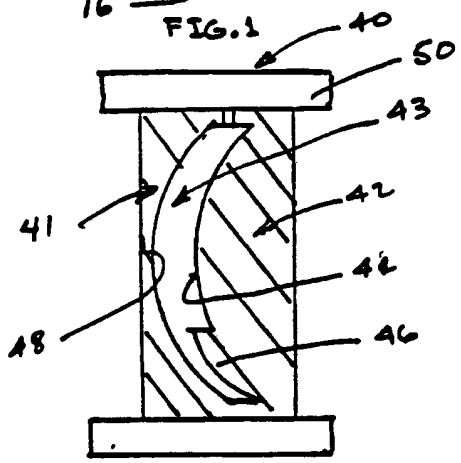

FIG.5

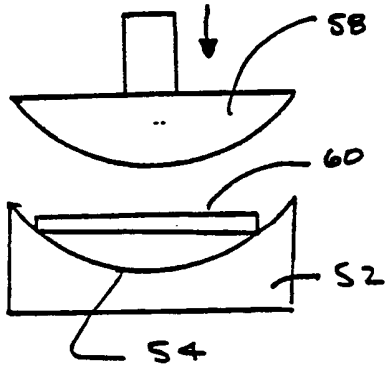

FIG. 6

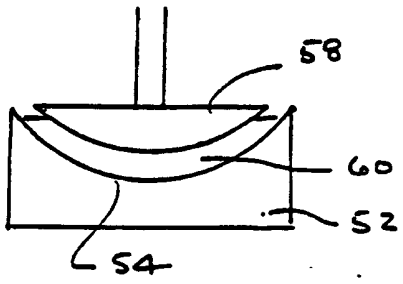

FIG. 7

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US89/02359

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(4): B29D 11/00

U.S.CL.: 264/2.5, 425/808

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	264/2.5 425/808

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	US, A, 3,871,803 (BEATTIE) 18 March 1975, see column 5, lines 46-61, column 8,lines 53-59, and column 9, lines 18-24.	1-13
Y	US. A, 4,279,401 (RAMIREZ ET AL) 21 July 1981, see column 2, lines 64-66, and column 3, lines 4-9.	1-13
Y	US, A, 4,434,113 (NEEFE) 28 February 1984, see column 2, lines 41-43 and claim 1.	1-13
Y	US, A, 2,304,663 (SMITH ET AL) 08 December 1942, see page 1, lines 3-7 and page 2, lines 29-38.	14
Y	US. A, 2,333,051 (SMITH) 26 October 1943, see page 2, column 1, lines 24-42	14
A	US, A. 3,422,168 (BOWSER) 14 January 1969	1-13
A	US, A. 3,423,488 (BOWSER) 21 January 1969	1-13
A	US. A, 3,931,373 (BEATTIE) 06 January 1976	1-13

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IV. CERTIFICATI N

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
04 August 1989	05 SEP 1989
International Searching Authority	**Signature of Authorized Officer**
ISA/US	James B. Lowe JAMES B. LOWE

Form PCT/ISA/210 (second sheet) (Rev.11-87)

III. DOCUMENTS C NSIDERED T BE RELEVANT (CONTINUED FROM THE SEC ND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 3,428,533 (PICHEL) 18 February 1969	4
A	US, A, 4,165,158 (TRAVNICEK) 21 August 1979	4